

Hit by hit track pitch calculation for ArgoNeuT

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Motivation

- Ornella's talk on analysis related topics
(Projects-doc-1544-v2):

Software tools

- 3D Reco to be improved for non straight-line tracks
 - Calculation of track pitch length hit-by-hit (needed for the calorimetric reconstruction)

Tingjun, Jonathan

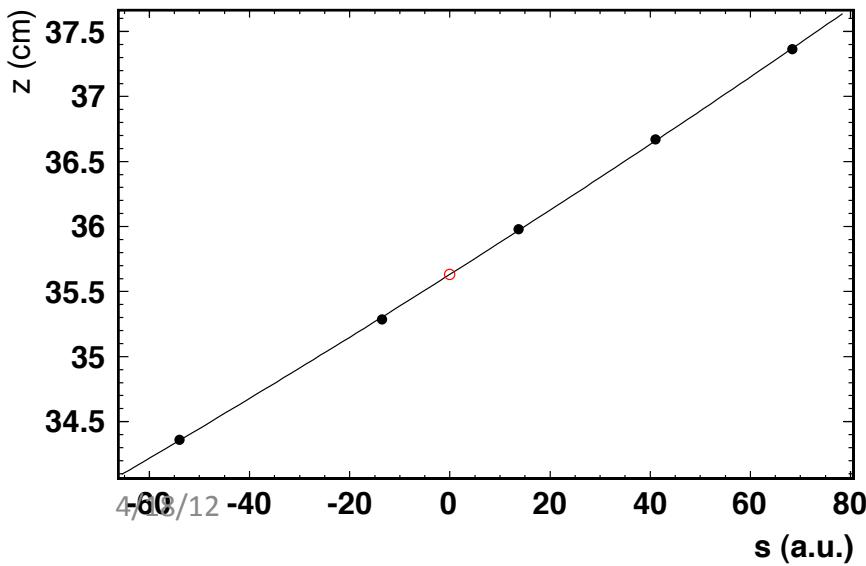
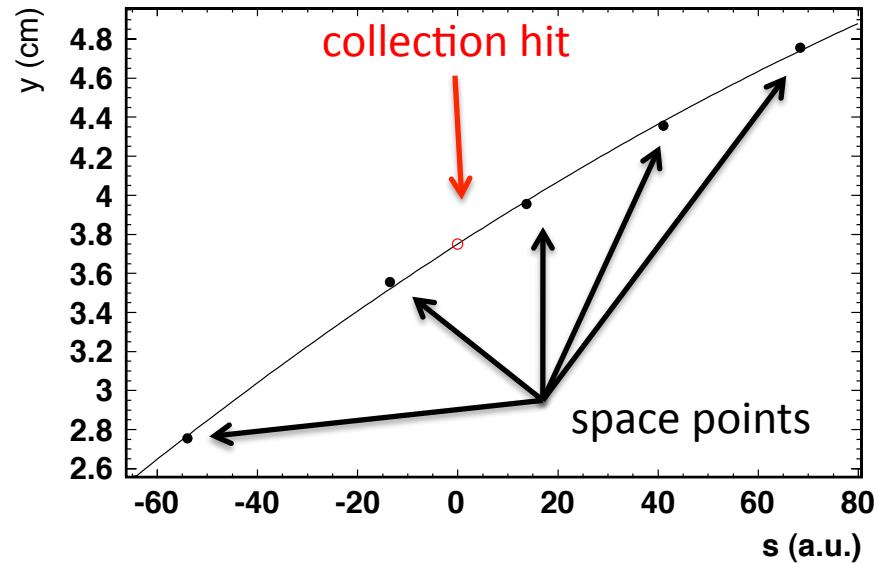
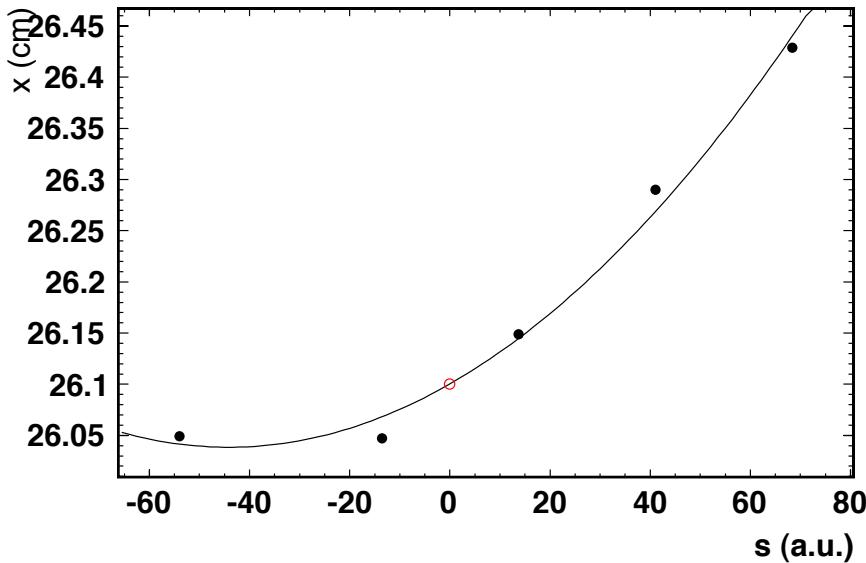
What are the problems?

- Currently only hits in the collection view are used for calorimetry.
 - If $\text{Nhits_col} > \text{Nhits_ind}$, some collection hits cannot be matched to space points, no $d\text{Edx}$, range_residual information available for these hits
- Currently track pitch is calculated globally using track direction, hit-by-hit pitch calculation is preferred especially for curved tracks.
- Possible solution
 - Without changes to tracking algorithm, one can attempt to calculate (x,y,z) coordinates of each collection hit through interpolation using adjacent space points.

Details of calculations

- Project all space points (3D) to the collection view (2D). For each collection hit (2D), calculated the distance to all the projected space points:
 - $s = \pm\sqrt{(\Delta w^* 13.5)^2 + \Delta t^2}$
 - Δw is the difference in wire numbers between collection hit and projected space point
 - Δt is the different in times between collection hit and projected space point
 - The sign depends on which side of the collection hit the projected space point is on
- Find the 5 nearest space point
 - Can be less than 5 if the track is short
 - Minimal $s = 0$ if the collection hit can be matched to a space point
- Plot $x-s$, $y-s$, $z-s$, fit to pol2 if $nhits > 2$, to pol1 if $nhits = 2$
 - $x(0)$, $y(0)$, $z(0)$ are the 3D coordinates of the collection hit
 - $dx/ds(0)$, $dy/ds(0)$, $dz/ds(0)$ represent the local track direction and can be used to calculate track pitch: hit-by-hit pitch

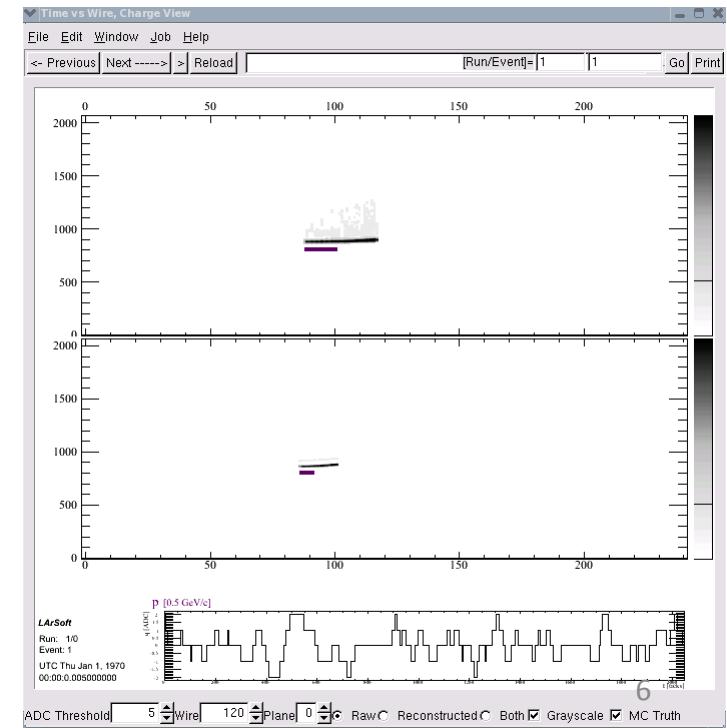
One example



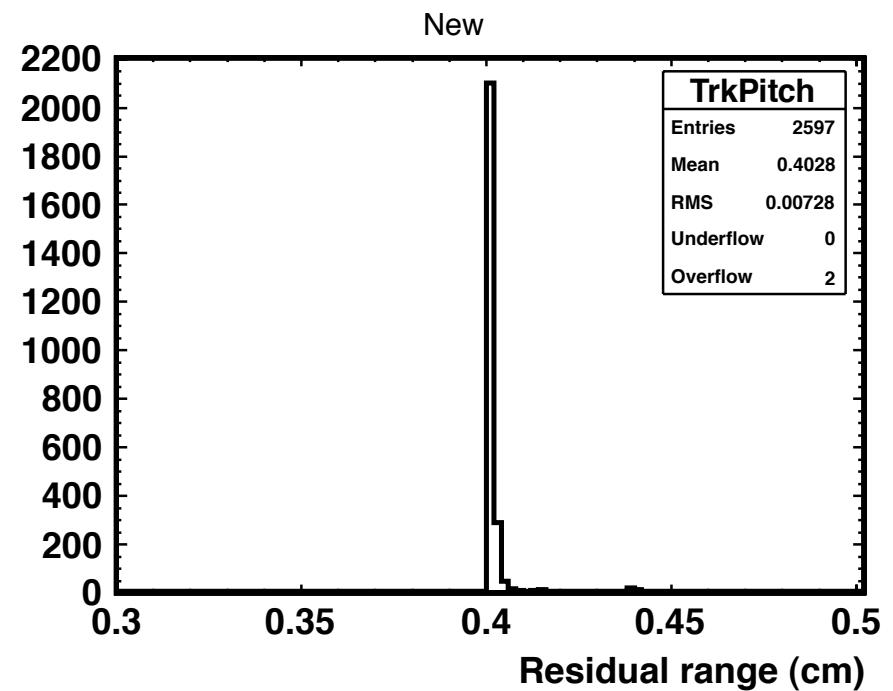
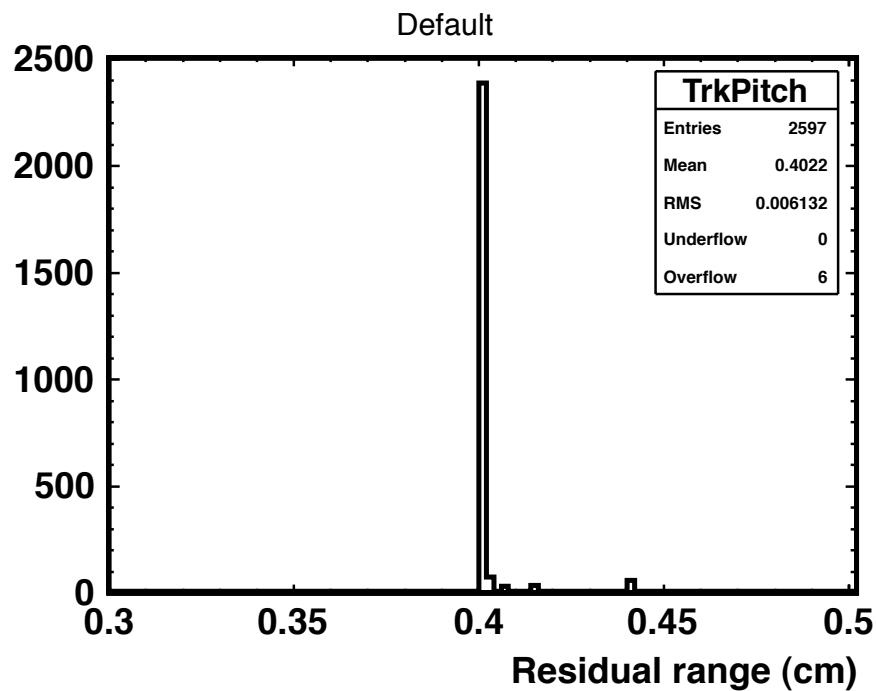
- Most of tracks are quite straight
- This is one rare example that shows visible curvatures

Test with MC

- Generate 100 MC single proton events
- $P=0.5 \text{ GeV}/c$, direction is in parallel with the wire planes, 30 degrees w.r.t. the beam direction
- Contained
- More hits in collection view
- Using fcl file from Kinga
 - Track3DReco

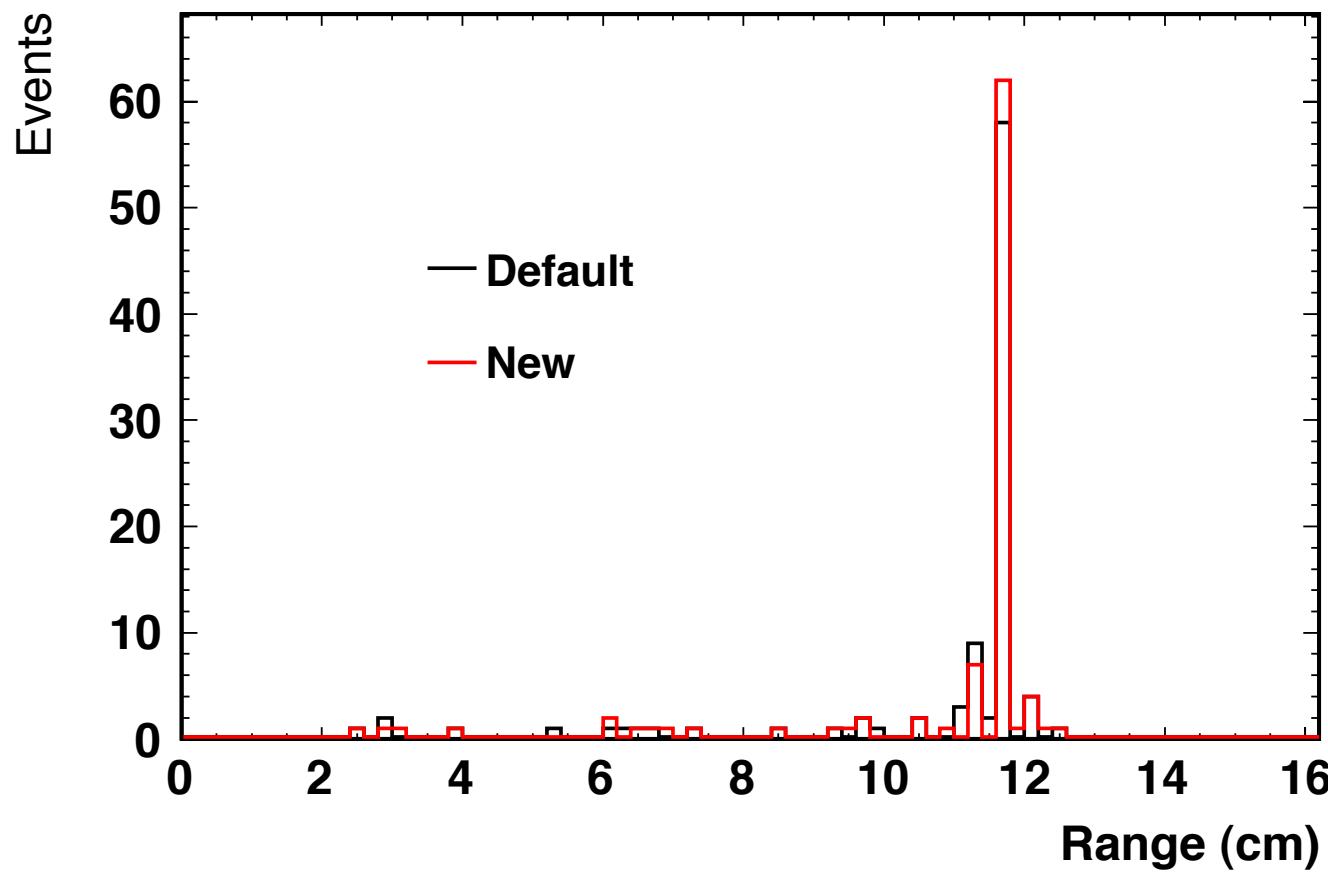


Track pitch

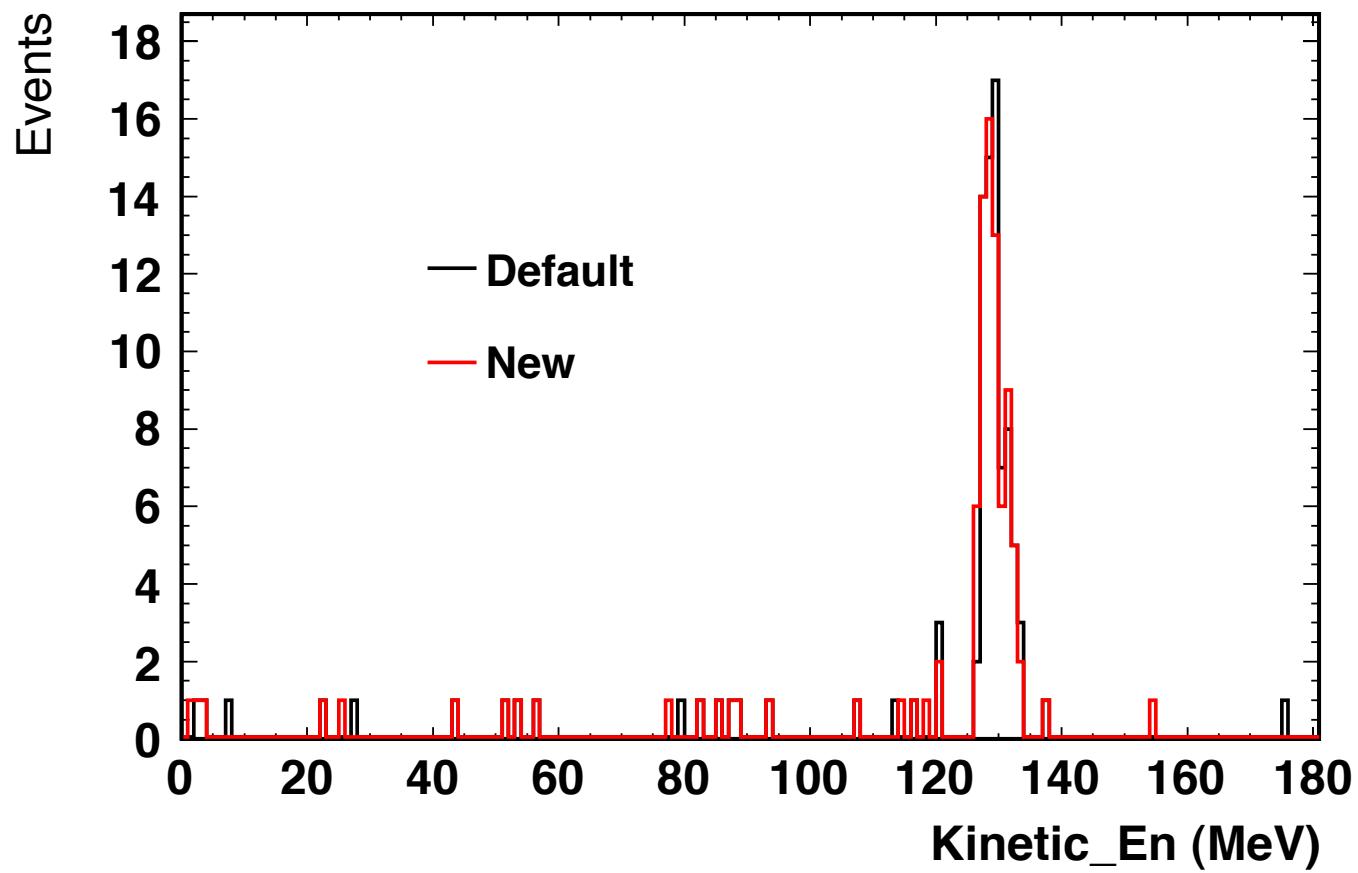


- Track pitches calculated with two methods are quite similar
 - Straight tracks
- New method gives slightly larger RMS

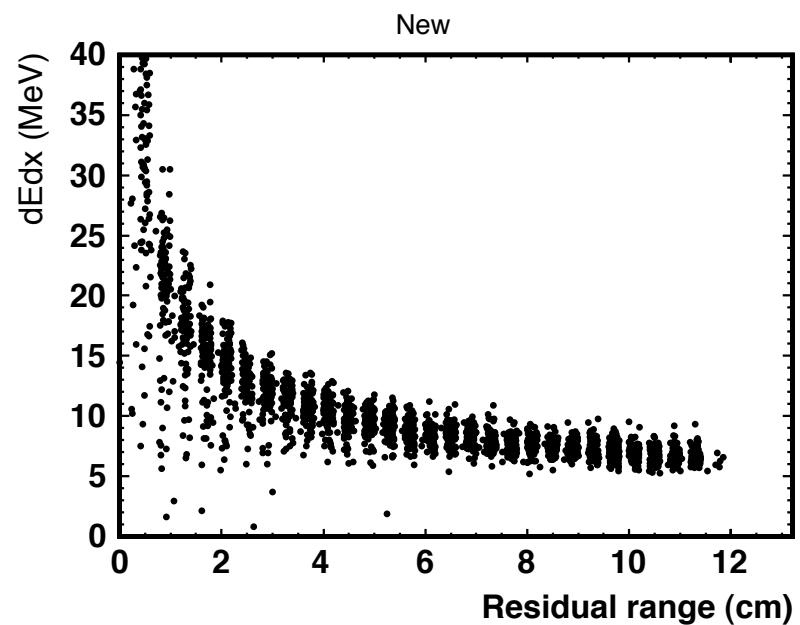
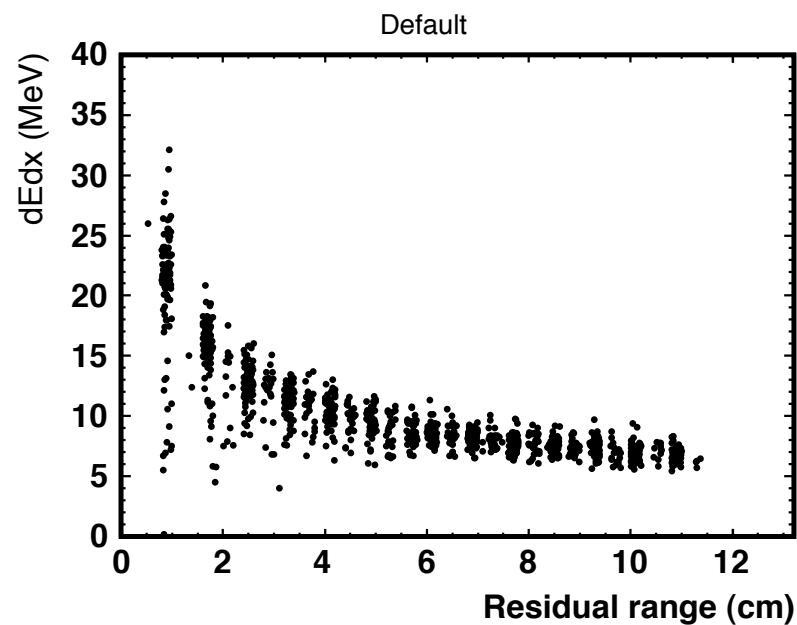
Range



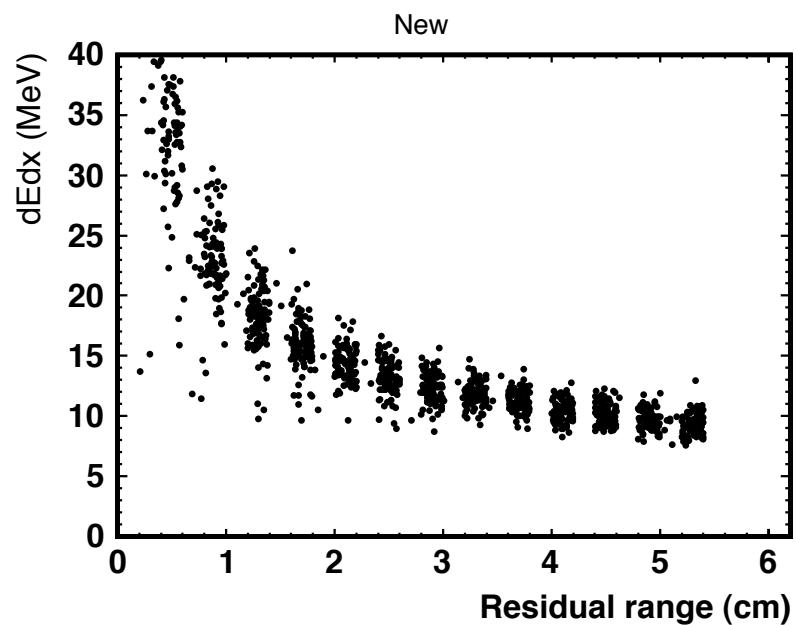
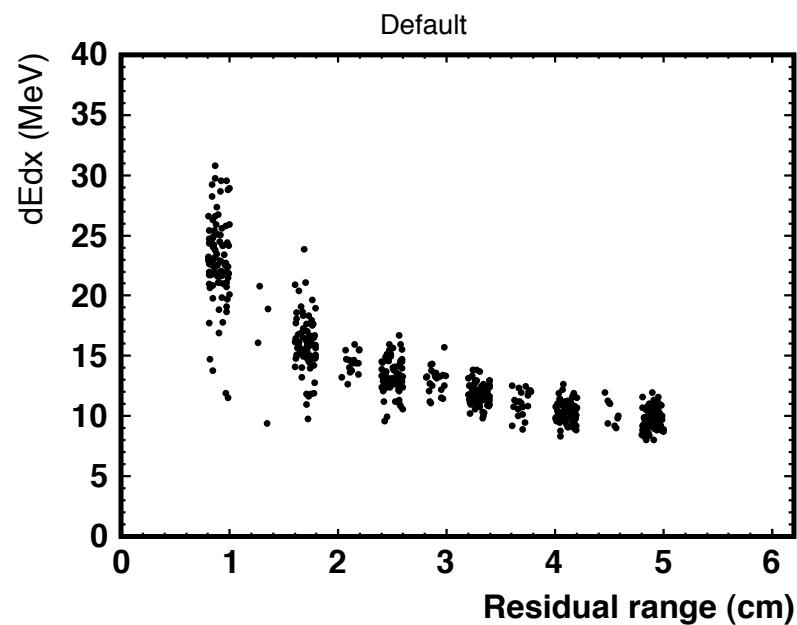
Kinematic energy



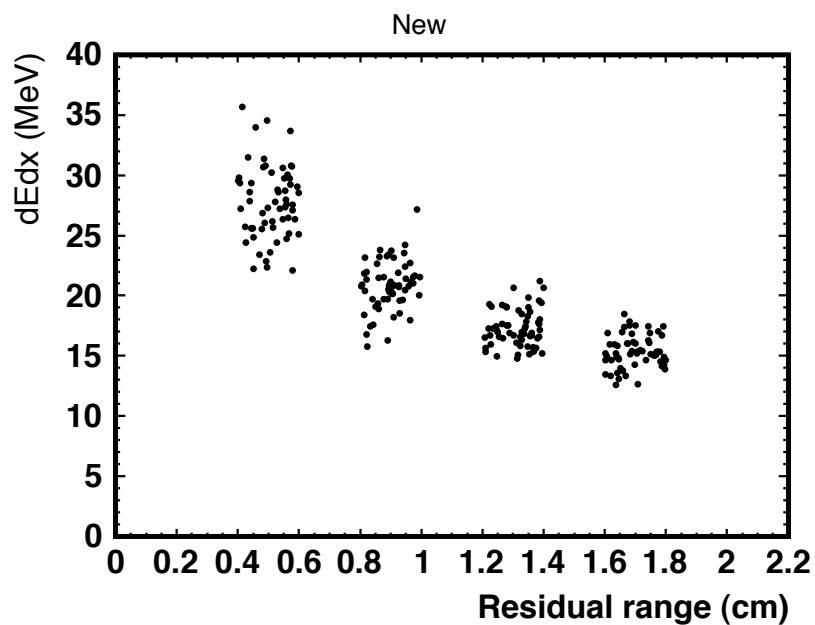
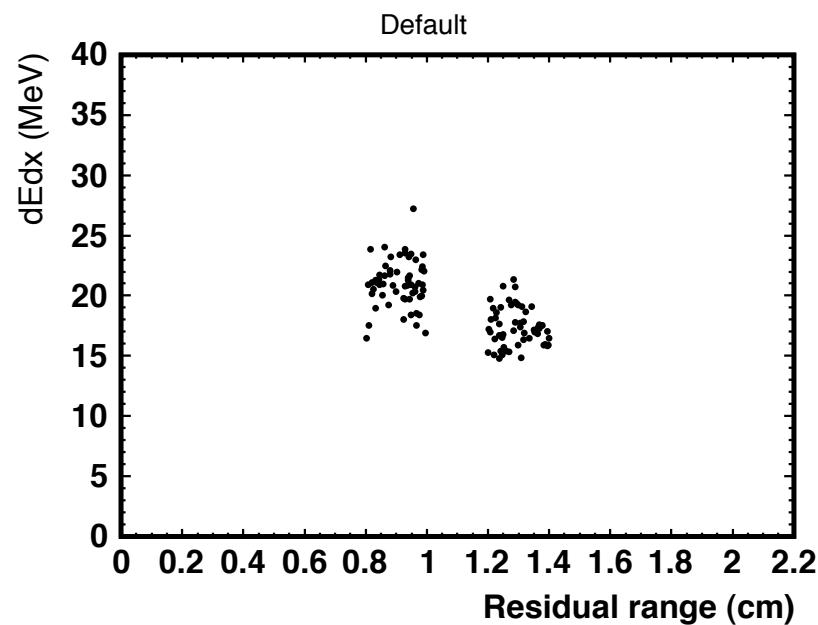
dE/dx vs residual ($P=0.5$ GeV/c)



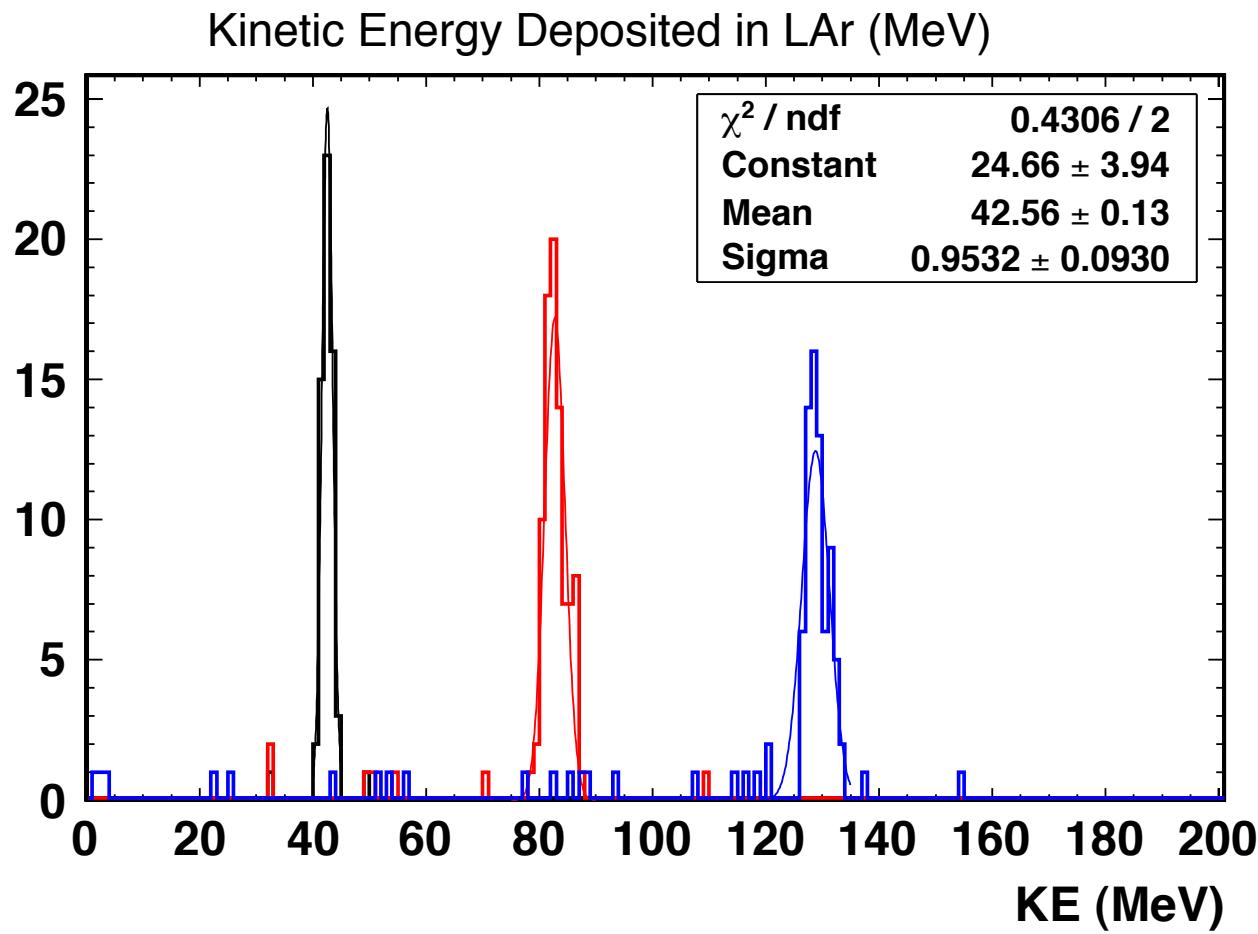
dE/dx vs residual ($P=0.4$ GeV/c)



dE/dx vs residual ($P=0.3$ GeV/c)

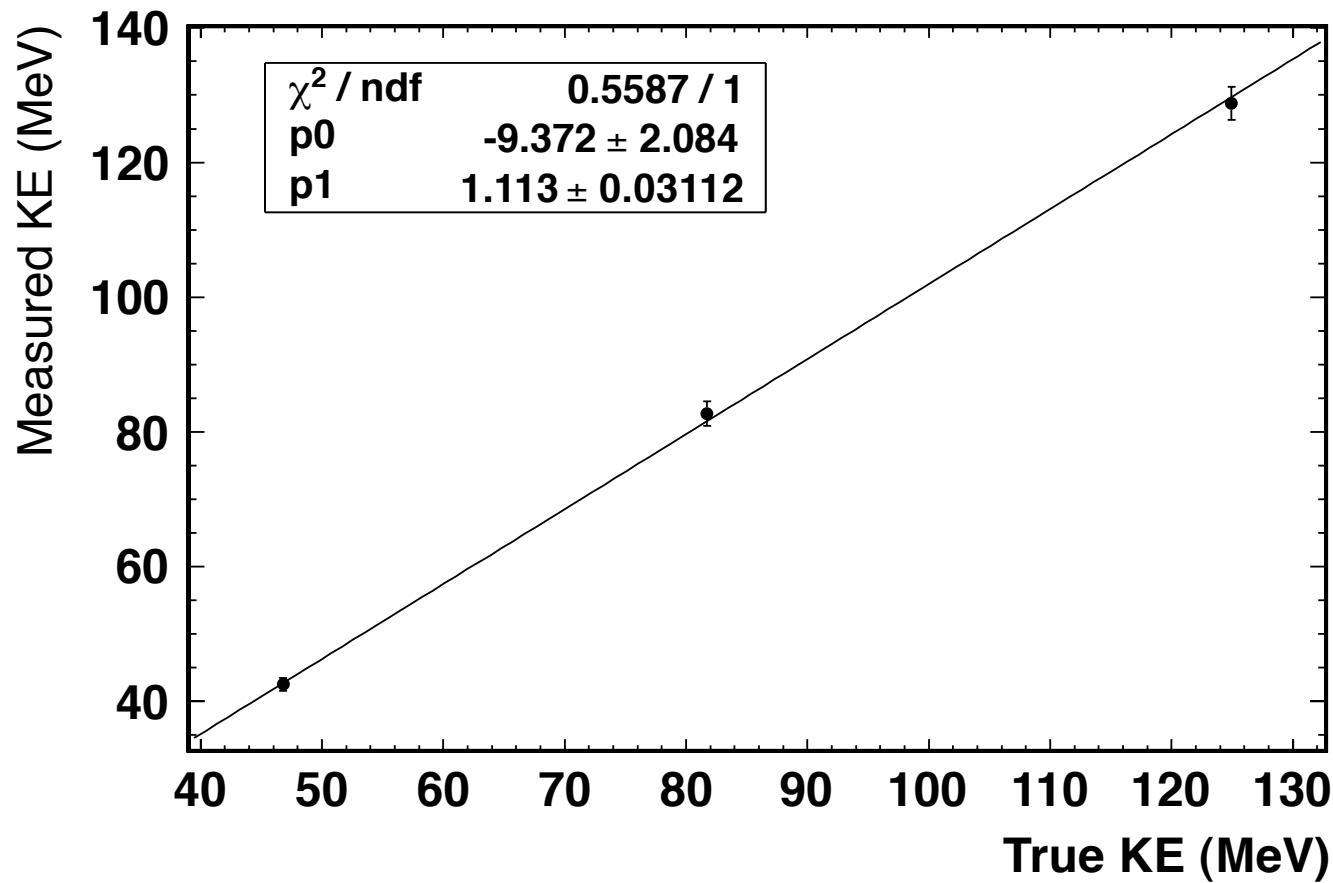


Kinematic energies

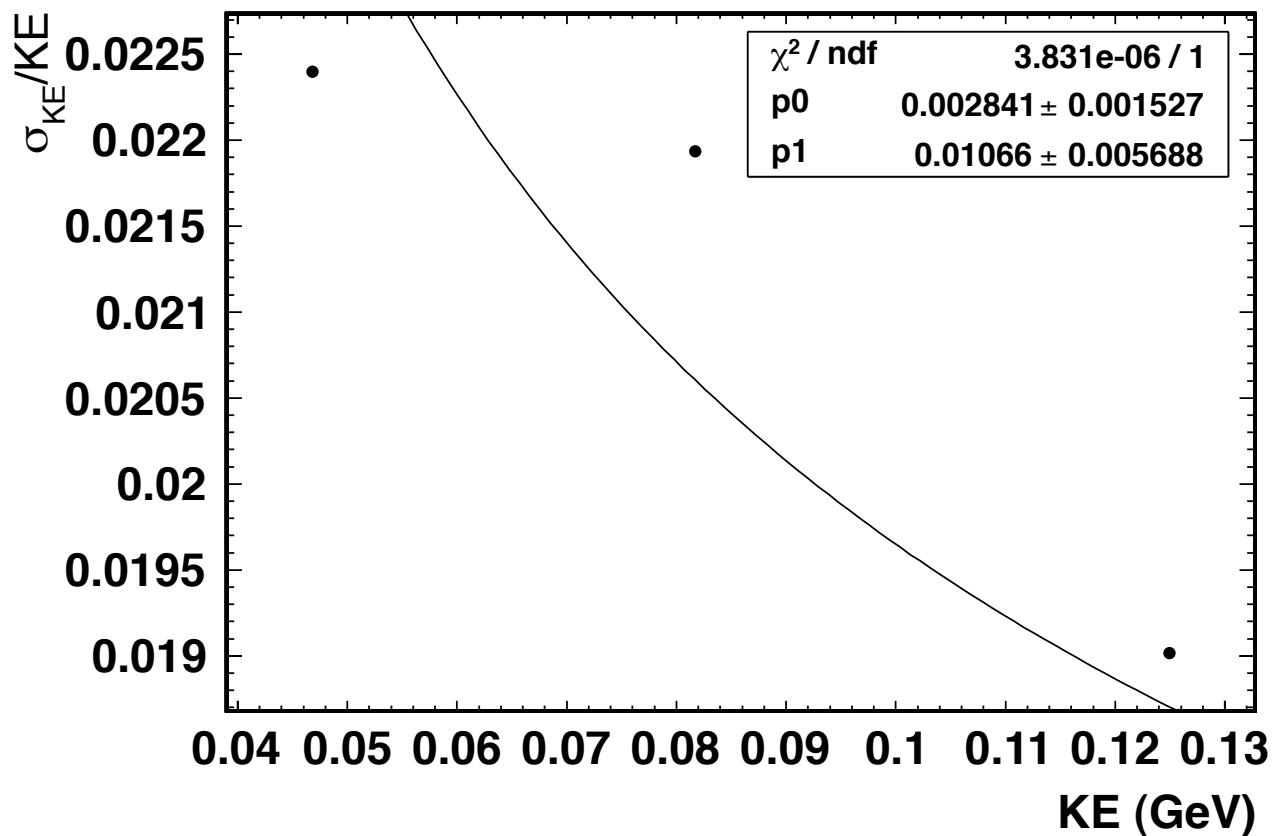


Fit a Gaussian function to each of the histograms

Measured KE vs true KE



Resolution vs KE



$$\sigma_{KE}/KE = p_0/\sqrt{KE} + p_1$$

Very good energy resolution ~2%

MINOS: ~59% at 1 GeV

Conclusions

- We tried to calculate track pitch using adjacent space points.
- The method works fine with MC proton tracks.
- Would like to test it on curved tracks and data events.
- Implement one function in Calorimetry
 - `void calo::Calorimetry::GetPitch(art::Ptr<recob::Hit> hit, art::Ptr<recob::Track> track, double *xyz3d, double &pitch)`
 - Inputs: collection hit, track
 - Outputs: xyz coordinates and pitch for the collection hit
- `physics.analyzers.calo.PitchPerHit`: 1 (new method), 0 (default method)
- Code not committed yet.